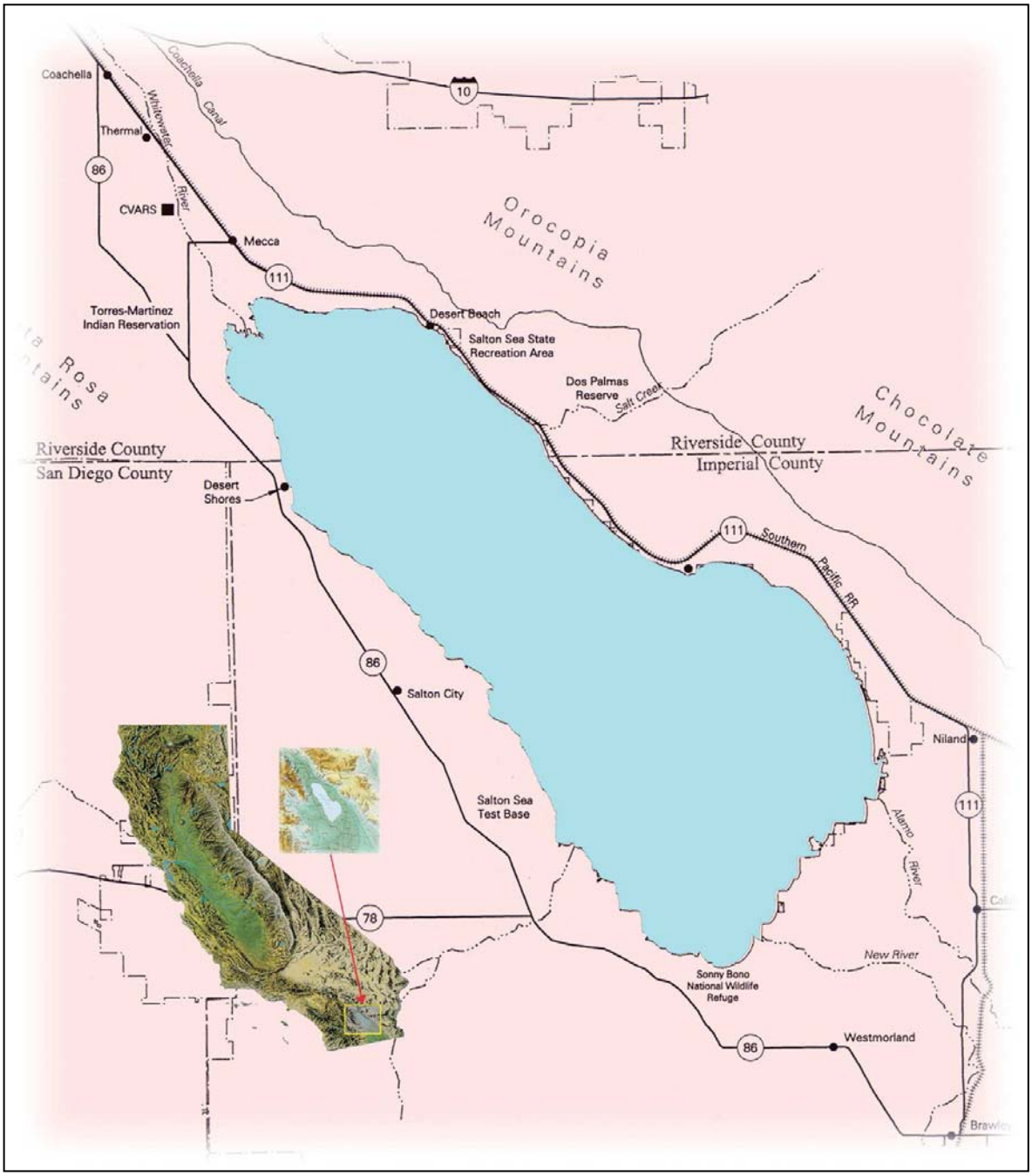
# SALTON SEA RESTORATION

## Final Preferred Project Report: Executive Summary

Salton Sea Authority

**July 2004**

Document prepared by Tetra Tech, Inc.




**Salton Sea Location Map**

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# EXECUTIVE SUMMARY

The Salton Sea is located in a closed basin in Riverside and Imperial Counties in southern California, south of Indio and north of El Centro. The Sea is more than 220 feet below sea level and has no natural outlet. The Salton Sea Basin is part of the Lower Colorado River Delta system and historically lakes have existed in this basin as the course of the Colorado River has shifted. The current body of water formed in 1905 when a levee break along the Colorado River caused flows from the Colorado River to enter the basin for about 18 months. Since 1905, the Sea has fluctuated in size with varying inflow, and it recently has had a surface area of 365 square miles.

A balance between inflowing water and evaporation has sustained the Sea in the past. However, with no outlet, any salts that are dissolved in the inflow are trapped, although some do precipitate. Salt concentrations are rising and are currently about 44,000 milligrams per liter (mg/L), or about 25 percent higher than ocean water. Salinity will continue to rise under current conditions. As a result of recently approved water transfers, the inflow to the Sea is expected to be less than it has been in the past. A reduction in inflow will cause the Sea to shrink and cause salinity to rise faster than it would have without a reduction in inflow.

The Salton Sea Reclamation Act of 1998 directed that studies be conducted to evaluate the feasibility of possible actions to allow continued uses at the Sea. Following the passage of the Act, a study was initiated to develop alternative measures to address rising salinity and other problems at the Sea.

In April 2003, the Salton Sea Authority (Authority) Board of Directors (Board) endorsed moving forward with an Integrated Water Management Plan for the Salton Sea. Recognizing that inflows to the Sea are likely to be reduced in the near future, the Plan evolved from recent concepts for a smaller Sea as well as earlier work by the Authority and the Bureau of Reclamation (Reclamation). The Authority subsequently commissioned the engineering feasibility studies and further analysis of the Integrated Plan documented in this report.

During 2003, the Quantification Settlement Agreement (QSA) was also in the process of being approved and legislation was developed to acknowledge the linkage between water transfers and the health of the Salton Sea. The QSA will allow for transfers of Colorado River Water out of the Imperial Valley. Such transfers are expected to substantially reduce the inflow to the Salton Sea. In association with the approval of the QSA, three bills were signed into law in September 2003 that specify a State-led program to develop a preferred restoration alternative by December 2006. The package of legislation also provides a mechanism to generate up to $300 million for Salton Sea restoration through the sale of transferred Colorado River water. The State is now in the process of implementing the planning requirements for this suite of legislative bills dealing with Salton Sea restoration.

## Overview of Report

This report documents a two-step process that has led to the identification of a preferred project for Salton Sea restoration. It provides the background for this process by discussing how the Sea could respond to inflow reductions, and by providing an overview of restoration options. The report then presents the first step of the process, which is a logic-tree evaluation that illustrates how features of restoration options can be eliminated through a series of queries. For example, one query is "Would pump-in/pump-out systems work?" referring to the practicality of systems such as pipelines that would exchange Salton Sea water with ocean water. This first step of the process documents the logic that has been used to eliminate unreasonable options and to identify the most feasible restoration strategy. In the second step in the process, alternatives are formulated from this strategy and ranked with respect to the program objectives. This step leads to a preferred conceptual alternative. Finally, this report concludes with a complete discussion of the preferred alternative concept, including its features, cost analyses, water surface elevations, performance factors, program phasing, and implementation.

## Program Objectives

On November 12, 1998, Congress enacted Public Law 105-372, The Salton Sea Reclamation Act of 1998. This Act authorized the Secretary of the Interior to complete studies of options that:

1. Permit the continued use of the Salton Sea as a reservoir for irrigation drainage,
2. Reduce and stabilize the overall salinity of the Salton Sea,
3. Stabilize the surface elevation of the Salton Sea,
4. Reclaim, in the long term, healthy fish and wildlife resources and their habitats, and
5. Enhance the potential for recreational uses and economic development of the Salton Sea.

Key program objectives have been developed to complement and provide more specifics to these goals that were included in the Reclamation Act and to incorporate work done by the Authority and Reclamation since 1998. These objectives reflect the current needs of the restoration effort with respect to the present understanding of the future volumes of water that will flow into the Sea. The current program objectives are as follows:

- Preserve the Sea as a repository for agricultural runoff
- Provide a large marine lake with stable elevation
- Improve water quality: salinity

- Improve water quality: nutrients/other constituents
- Maintain and improve habitat
- Achieve water quality and habitat objectives in a timely manner
- Respond to inflow changes
- Increase recreational and economic potential
- Address air quality concerns
- Provide high safety rating/low risk of failure
- Overcome institutional barriers/public acceptance
- Achieve reasonable cost/high probability of financing

## Inflows to the Sea

With implementation of the QSA, the average inflow to the Sea is expected to decrease over about 15 to 20 years from over 1,300,000 acre-feet/year to an expected inflow of about 930,000 acre-feet/year. While the water transfer agreements contain predictable transfer schedules, there is an option for transferring up to 1.6 million acre feet of additional water if the water is not needed to mitigate effects to the Salton Sea. In addition, inflow to the New River from Mexico, where the flow originates, may also be subject to future reductions. For example, reductions in surplus Colorado River flows to Mexico could, in turn, affect New River flows back across the border. It is also possible that the Coachella Valley groundwater management program would affect inflows. These variables translate to an uncertainty with respect to actual Salton Sea inflows. Therefore, three inflow scenarios are considered in this report:

1. The anticipated QSA schedule that includes water releases to mitigate effects to the Salton Sea over the next 15 years;

2. The QSA schedule with the mitigation water terminated in 2006 and sale of additional water to generate restoration funds; and

3. A schedule that would reduce average inflow to about 800,000 acre-feet/year.

Under all three inflow scenarios, without restoration, salinity in the Sea would more than double over a period of 20 to 25 years, while the water surface elevation would decrease by about 20 feet over the same period.

## Overview of Restoration Options

Restoration options have evolved through a process that has involved planning studies, engineering analysis, scientific oversight, and environmental reviews. Some

salinity control methods discussed in this report date back to the 1960s and possibly earlier. The amount of salt that would have to be removed by these methods would depend on future inflows. With reduced inflow, the Sea will begin to shrink and salts will be concentrated; therefore, more salts would need to be removed to control salinity. If the inflow continues to be reduced in the future, greater amounts of salt would need to be removed to meet project objectives.

To address the rising salinity of the Sea, a surrogate outlet must be established. Three basic methods have been considered:

- Pump water out of the Sea and discharge it to some remote location. This could be accomplished by combinations of pipelines and canals to the ocean, the Gulf of California, or some other remote location.

- Pump water out of the Sea and discharge it to local desalting plants or evaporation ponds, possibly in combination with mechanical processes that enhance the rate of evaporation. This would require disposal of salt residues near or within impoundments in the Sea.

- Divide the Sea so that one portion acts as a receptor for the discharge from another portion. Through the construction of retention structures, salts would be allowed to concentrate in one area while salinity levels in the remaining area would be controlled.

A myriad of alternatives have been identified over the years to provide one or another of those outlet scenarios, some of which also help control the elevation of the water surface of the Sea. This report discusses those that have been viewed as the most promising in the past or that have passed earlier screening analyses.

## Logical Process for Screening Alternatives

The various categories of alternatives for solving the problems at the Salton Sea can be reviewed through a logical sequence of decisions given the current and likely future conditions at the Sea. The process begins by developing a series of questions which provide a roadmap through a sequence of decision points leading to a logical preferred restoration strategy. This screening process reveals that most alternatives that have been considered in the past do not perform well under reduced inflow conditions. In addition, with reduced inflows most systems need to become very large to respond to rapidly increasing salinity, and consequently, they would become highly expensive. In addition, most processes that remove salt also remove water and thus would exacerbate concerns about elevation decreases under the QSA.

The logic process leads to the conclusion that a concept that bisects the Sea in half may be the most effective restoration strategy. This concept relies on building a causeway/retention structure across the midsection of the Sea to separate hyper-saline and marine basins of the Sea from one another. If the structure is placed at the approximate midsection of the Sea where the west and east shorelines are nearest,

the length of the barrier would be around 8.5 miles, and less if it is designed to work with the Sea at a lower elevation than the current situation. This area is also attractive because the water is shallower than areas to the immediate south and north, which will help reduce construction costs.

A major challenge to this divided lake concept is the feasibility of constructing a facility that is cost effective. The foundation conditions of the Sea have been investigated and found to be composed of a relatively thick layer of fine-grained sediments that create an engineering design challenge. However, conceptual alternative designs of a mid-Sea facility are currently underway and based on preliminary engineering evaluations it is believed that a suitable structure could be constructed at a reasonable cost.

## Evaluation of Reasonable Alternatives

The logical process for reviewing alternatives led to the conclusion that alternatives that employ a central dike or dam facility are worthy of further investigation. Such a concept would include a smaller marine lake, and could be developed along one of two options using a central dike or dam: a marine lake in the north or a marine lake in the south. The features and benefits of south and north marine lake concepts based on a dividing structure at this location are described briefly below. There is also a choice about whether or not to control elevation.

**South marine lake**—A marine lake in the south would have a maximum area on the order of 210 square miles and require an inflow of 980,000 acre feet per year to sustain it at current elevation of about -227 feet relative to mean sea level (msl). The area would be smaller if the lake was to be maintained at a lower elevation. A southern marine lake would be consistent with current wildlife refuge boundaries. The southern marine lake would also take advantage of inflows from the New and Alamo Rivers such that rerouting or transporting these flows would not be necessary. Concentrations of selenium and several other contaminants in the sediments are highest in the northern half of the Sea. Allowing portions of this basin to recede would expose the sediments creating the potential for human health and wildlife impacts.

**North marine lake**—A marine lake in the northern portion of the Sea would be on the order of 150 square miles and require an inflow of around 800,000 acre feet per year. A marine lake in the north would reduce the concern over selenium sediment effects by effectively capping the sediments with the marine lake. There are also established communities in the northern portion of the Sea such as Desert Shores, Salton City, and North Shore that would benefit from a restored Sea. These communities would likely experience renewed economic development including commercial, recreational, and residential developments. The Torres Martinez Tribe would also benefit from a restored Sea and could implement various economic and natural resource projects. The exposure of submerged areas in the south would allow for geothermal exploration and development of known geothermal resources.

**Elevation control**—The next issue to be addressed is whether or not to control the water elevation in the marine lake, and if so, what approach to use. A barrier could be used with no elevation control. A retention structure could be used that maintains elevation at current levels. Or, a retention structure could be used that takes advantage of a reduced water surface level.

Given the above considerations, four alternative configurations have been identified for evaluation:

- **South Marine Lake without Elevation Control**—The simplest configuration would be to construct a central barrier and allow the New and Alamo rivers to flow into the south basin and create a marine lake with hyper-saline conditions in the north.

- **South Marine Lake with Elevation Control**—This configuration would be similar to the previous alternative, except that the central barrier would need to be taller and more robust to impound water in the south and create a higher water surface than in the north.

- **North Marine Lake with Elevation Control**— This concept would be similar to the previous alternative with the north-south configuration reversed. In this case, the New and Alamo rivers would need to be extended to the north to provide freshwater inflows to control salinity in the north basin.

- **No Marine Lake**—This alternative is considered in case a mid-Sea barrier or impoundment structure proves to be infeasible or too costly. It would include wetland and habitat restoration elements to achieve as many objectives as possible without maintaining a large lake with a marine fishery.

## Evaluation of Reasonable Alternatives

The four reasonable alternatives discussed above were evaluated against the program objectives. For each objective, the alternatives were ranked on the basis of best judgment as to how they would perform under inflows that would be expected with the QSA in place. Finally, an overall composite ranking was developed. A summary of the evaluation process is provided in Table ES-1, where the highest ranking is given a number "1" and the lowest is given a "4."

In addition to rankings against each objective, Table ES-1 shows: (1) an average ranking score calculated by taking a simple average of the rank values for each of the objectives; (2) the number of top rankings; (3) the number of lowest rankings; and (4) the overall average ranking based on the three previous statistics. Based on the data presented here, the **North Lake with Elevation Control alternative received the top ranking and is recommended for consideration as the preferred restoration strategy** for the Salton Sea. As indicated in Table ES-1, the North Lake

**Table ES-1. Evaluation of Restoration Options**

| Objectives | Restoration Alternative | | | |
|---|---|---|---|---|
| **Project Objectives Used in this Report ⇓** | South Marine Lake wo Elevation Control | South Marine Lake w Elevation Control | North Marine Lake w Elevation Control | No Marine Lake |
| Preserve Sea as Repository for Agricultural Runoff | 1 | 1 | 1 | 1 |
| Provide Large Marine Lake with Stable Elevation | 3 | 1 | 2 | 4 |
| Improve Water Quality: Salinity | 1 | 1 | 1 | 4 |
| Improve Water Quality: Nutrients/Other Constituents | 2 | 2 | 1 | 4 |
| Maintain and Improve Habitat | 3 | 2 | 1 | 4 |
| Time to Achieve Water Quality and Habitat Objectives | 3 | 1 | 2 | 4 |
| Respond to Inflow Changes | 2 | 4 | 3 | 1 |
| Increase Recreational and Economic Potential | 3 | 2 | 1 | 4 |
| Address Air Quality ($PM_{10}$) Concerns | 3 | 1 | 1 | 3 |
| Provide High Safety Rating/Low Risk of Failure | 2 | 3 | 3 | 1 |
| Overcome Institutional Barriers/Public Acceptance | 3 | 2 | 1 | 4 |
| Reasonable Cost/High Probability of Financing | 3 | 4 | 2 | 1 |
| Average Score | 2.4 | 2.0 | 1.6 | 2.9 |
| Number of Top Rankings | 2 | 5 | 7 | 4 |
| Number of Lowest Rankings | 1 | 3 | 1 | 8 |
| Overall Ranking | 3 | 2 | 1 | 4 |

with Elevation Control alternative received the highest ranking with respect to seven of the 12 objectives and the lowest ranking for only one objective.

## The Preferred Project: A Vision for the Future

Starting with the north lake concept and adding other features, a preferred project emerges that has the potential to create outstanding opportunities for the Imperial and Coachella valleys. This vision of the future combines a healthier and more stable marine lake that has lower salinity with a variety of ecological and recreational features. It also includes measures to mitigate potential air quality degradation that may be associated with sediments exposed by declining lake levels that result from decreases in inflow. The concept is illustrated in Figure ES-1.

Figure ES-1 illustrates the wide range of habitat and recreational features that could be included as part of the vision of the future for the Salton Sea ecosystem. The features of the preferred project are conceptual. Some features have been developed in more detail, such as the central causeway/retention structure. Technical reports are underway to further describe the causeway/dike and other features, such as the shallow water habitat. Other features, such as fresh water recreational lakes and wetlands, were reviewed by an Outdoor Recreation Advisory Task Force.

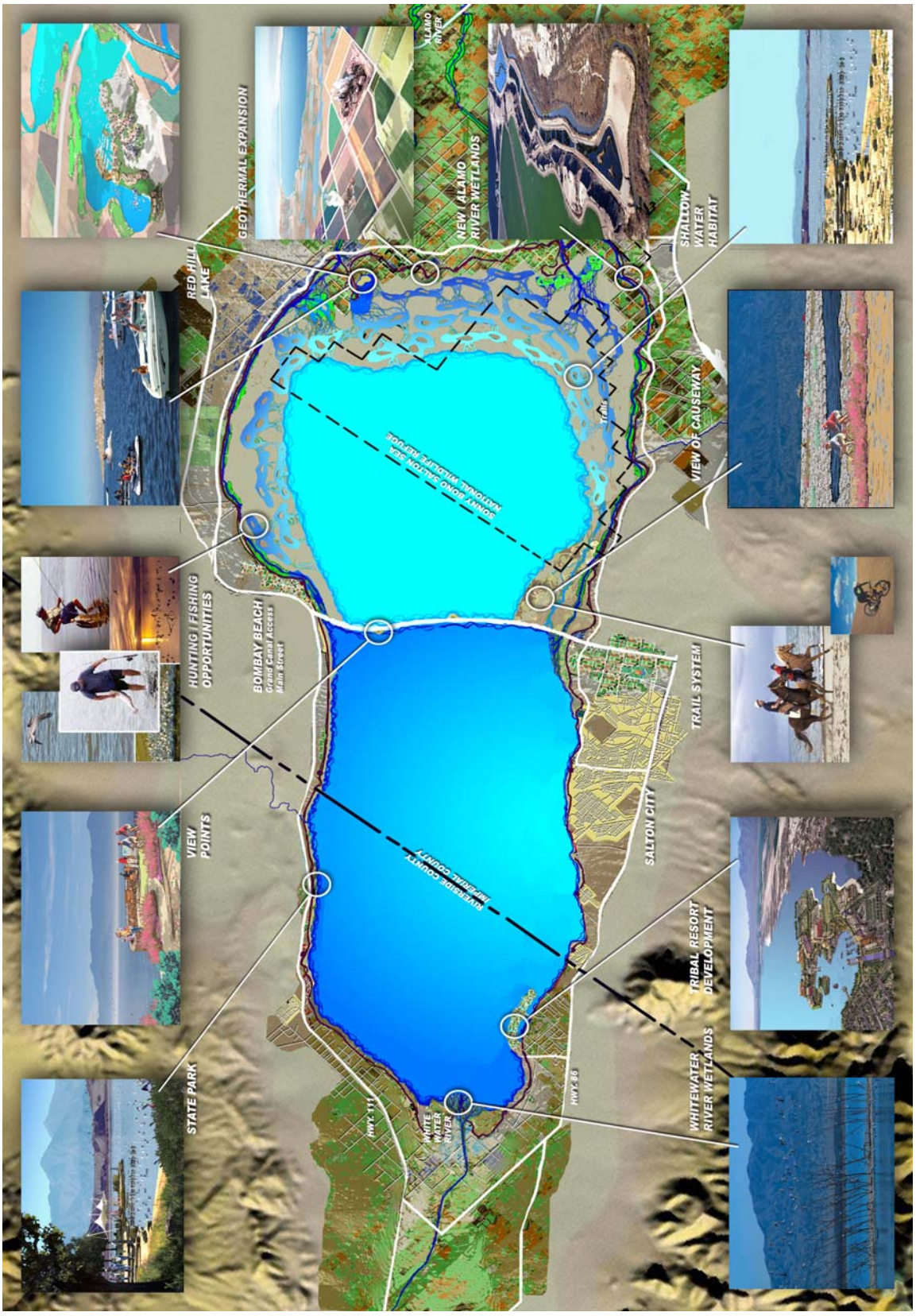


**Figure ES-1. Preferred Alternative Concept Plan for the Salton Sea Area.**

The Recreational Task Force included representatives of recreational groups, cities and other organizations, primarily from the north end of the Imperial Valley. During initial meetings of the Task Force, the members voiced support for many elements of the preferred project. The final report from the Task Force, including their recommendations, is included as an appendix to the main report.

## Design Features

Two of the most important design features of the preferred plan are the structural design of the central causeway/retention structure and the inflow requirement to support the plan. A working group of 15 civil and geotechnical engineers was convened to review the feasibility of constructing a dike, or retention structure/causeway anywhere within the Salton Sea. After considering several possible methods, the preliminary conclusions indicate that a rock filled embankment may be the most cost effective construction method. The preferred restoration plan could be sustained by an average annual inflow of 800,000 acre-feet/year, and possibly somewhat lower inflows. The inflow would need to include about 600,000 acre-feet/year to sustain the north lake, with the remaining 200,000 acre-feet plus salt water discharges from the north lake supporting other habitat and recreational features.

## Performance and Phasing

The Salton Sea Accounting Model was used to evaluate the performance of the preferred project. The model indicates that if the marine lake is designed for a water surface elevation of -235 feet msl, and a decision is made to move forward with the program in the near future, then the target salinity of 35,000 mg/L could be achieved by 2013. The model suggests that the phasing schedule shown in Table ES-2 could be achieved for a design elevation of -235 feet msl.

## Target Elevation

A design elevation of around -235 feet msl is recommended for consideration as the target elevation. It would have a number of benefits including: (1) High enough elevation to allow for gravity flow of salt water to shallow habitat areas and for dust control; (2) Minimal dredging for access to communities, (3) Low enough to provide fall for river extensions; (4) Minimal salinity spike and short time to target salinity; and (5) Reasonable cost…at -235 feet msl the cost estimate for the retention structure is about $150 million less than it would be for the current lake elevation. There may also be some circumstances where -240 feet msl could be beneficial as the design lake level. If it appears that the construction schedule would need to be extended and if additional water can be sold to raise funds and expedite the water surface reduction to -240 feet msl, then an additional savings of about $100 million could be realized, with other factors being equal.

**Table ES-2. Proposed Timeline**

| Timeframe | Activity |
|---|---|
| 2004 | Federal, State & Local (SSA) Agencies Pledge to Work Together on Restoration, Enter an MOU |
| 2004 | State Advisory Committee Develops Criteria and Reviews Alternatives |
| 2004 | Begin Detailed Design |
| 2005 | SSA Establishes Tax Increment District |
| 2005 | Draft Project-Level Salton Sea Restoration EIR/EIS |
| 2005 | Final Project-Level Salton Sea Restoration EIR/EIS |
| 2006 | Complete Detailed Design |
| 2006 | Phase One Construction: Develop Quarry Site, Begin Wetlands and Interim Shallow Water Habitat Construction |
| 2006 | Mitigation Water Sold |
| 2007 | Phase Two Construction: Begin Extension of Rivers and Causeway |
| 2009 | Phase Three Construction: Begin Marina Dredging |
| 2010 | Complete Causeway |
| 2013 | North Lake Salinity Targets Met |
| 2015- | Phase Four Construction: Phased In Shallow Water Habitat |

## Cost and Financing

The construction cost of the program for a design elevation of -235 feet msl is estimated at between $650 and $730 million based on a conceptual-level cost analysis. This estimate includes the mid-Sea retention structure/causeway, appurtenances, dredging to communities, greenbelt channels to the north lake, a fresh water recreational lake, Torres Martinez wetlands/habitat, upstream wetlands, and an initial phase of shallow water habitat construction. Total annual operating expenses are estimated at about $10 million, including costs for maintenance of the mid-Sea retention structure, appurtenances and channels, and for future expansion and maintenance of shallow water habitat areas.

Potential financing sources include funds from Proposition 50, funds generated through the QSA legislation, local funds generated through formation of a Tax Increment District, and possible other State and Federal sources.

## Recommendation

The preferred project is an integrated multi-functional plan that is recommended as an opportunity to provide outstanding ecological, recreational and economic benefits to the Salton Sea area.